

Inelastic Light Scattering in the Coastal Zone and In Benthic Environments

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LONG-TERM GOAL

My long term goals are to experimentally determine the interrelationships and variability of optical properties in the ocean and atmosphere. I have been concentrating on aspects of scattering, both inelastic and elastic, and measurements of the radiance distribution in the ocean and atmosphere. These measurements can be combined to test and improve radiative transfer models, which are used to predict image and light transmission in the ocean.

SCIENTIFIC OBJECTIVES

Our near term objective is to characterize the inelastic scattering in clear water, coastal waters with high DOM concentrations, and the benthic environment (as part of the CoBOP program). In addition, as part of our CoBOP efforts we have designed and constructed an instrument to make in-situ bi-directional reflectance measurements of benthic surfaces.

APPROACH

Solar stimulated inelastic scattering

We use our Fraunhofer line technique to separate the inelastically scattered or fluoresced light from the elastically scattered or direct light (Ge et al, 1995). Data has been collected in several environments: clear open water, DOM rich water in Florida Bay, and in marine Benthic environments with CoBOP.

Bi-directional Reflectance instrument

We have built an instrument to measure the in-situ bi-directional reflectance of surfaces at 3 wavelengths (480, 565, and 650 nm were chosen because of the availability of bright LED sources). The instrument is basically a hemisphere with a radius of 10 cm, which is placed on the surface to be measured. The surface is sequentially illuminated at angles ranging from 0 to 65 degrees (0, 5, 15, 25, 35, 45, 55, 65 degrees). The reflected light is measured with fibers at the same zenith angles as the illumination and at 29 azimuthal angles from 0 to 360 degrees. The sample area is approximately 1 cm². Light from each viewing direction is collected with fiber optic collectors and then brought into a common "block array" which is imaged on a camera. In this way all viewing angles are collected at a single time greatly decreasing sample acquisition time. The instrument is small and compact enough for diver operation in-situ. The instrument will be used in field experiments in Biscayne Bay and at the CoBOP experiment sites.

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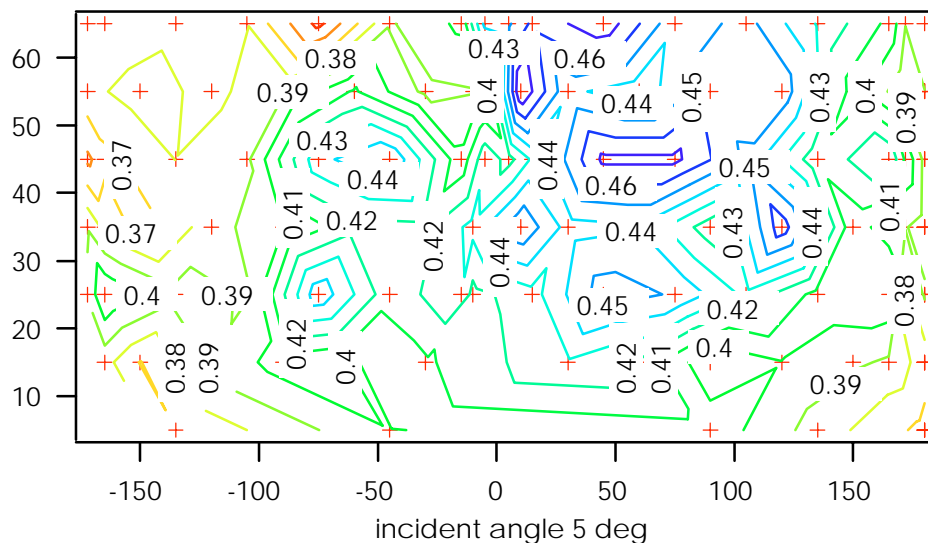
WORK COMPLETED

We have finished analyzing, writing and publishing manuscripts on inelastic measurements obtained during previous cruises in various environments (coastal, clear, and benthic).

The bi-directional reflectance instrument has been constructed and was fielded for its first test during the CoBOP 1998 field exercise at Lee Stocking Island, Bahamas. Since this test we have been performing extensive instrument tests to test the measurement accuracy and performance of the instrument.

RESULTS

Most of the past year has been spent building and testing the BRDF instrument. Unfortunately there was a problem with the instrument during the field exercise that corrupted the data obtained in the field. We have fixed this problem, and will be looking at the data to see what we can learn from it, however we did learn a lot about deployment and measurement issues during the trip. We devised several new sampling strategies to allow us to make measurements on very tenuous benthic surfaces, and other surfaces which we were not able to measure with the original instrument design. We have also made several modifications to the instrument to allow better operation in the field.



Above is shown an example BRDF for a dry sand sample, light incident angle is 5 degrees. Along the x-axis is azimuth direction, along the vertical axis is the zenith angle for viewing direction. As can be seen this sample is fairly diffuse, reflectance would be constant for a lambertian surface. The red crosses are points where the measurements have been taken showing how dense the measurement matrix is.

IMPACT/APPLICATION

The ability to measure the BRDF in-situ will allow for more accurate modeling of the light field in shallow waters. To date there are no good measurements of this parameter performed in-situ, thus the information will be invaluable for many optical models.

TRANSITIONS

At this point it is too early to talk about transitions in the bi-directional reflectance work. We are using the radiance distribution system, developed in earlier ONR work as part of our NASA sponsored satellite validation and calibration effort. This instrument provides the upwelling radiance distribution, which is used to determine the BRDF of the water column to adjust the nadir upwelling radiance to the satellite viewing angle.

RELATED PROJECTS

1 - With NASA support we have been making measurements of the in-water radiance distribution in clear water (using an instrument previously designed and built with ONR support).

REFERENCES

Y. Ge, K. J. Voss, and H. R. Gordon. 1995. In situ measurements of inelastic scattering in Monterey Bay using solar Fraunhofer lines. J. Geophys. Res., 100: 13,227 - 13,236.

My laboratories web page is <http://phyvax.ir.miami.edu:8001/optics/exp/mainpage.htm>. However as the post-doc involved with maintaining this page does atmospheric work, it is probably dominated by this portion of my groups effort.